What is claimed is:

1. A method of regulating the inhalation and exhalation of breathable gas to and from a pilot's airway in response to the pilot's spontaneous inhalation and exhalation breathing phases, while the pilot is experiencing excessive g-forces and equipped with an anti-g-force suit and a face mask having a common inlet/outlet port in fluid communication with the pilot's airway comprising:

providing a source of pressurized breathable gas;

providing an inhalation valve connected between the source of pressurized gas and the inlet/outlet port of the face mask;

providing an exhalation valve connected between the inlet/outlet port of the face mask and a low pressure area;

opening and closing the inhalation and exhalation valves, respectively, during the inhalation phase and controlling the pressure of gas supplied to the inlet/outlet port so that the pressure rises from a predetermined minimum to a predetermined maximum to increase the volume of breathable gas supplied to the pilot's lungs; and

opening and closing the exhalation and inhalation valves, respectively, during the exhalation phase and controlling the pressure in the inlet/outlet port so that the pressure falls from the predetermined maximum to the predetermined minimum to decrease

the exhalation effort required by the pilot, the maximum pressure being a function of the g-forces to which the pilot is being subjected, the minimum pressure having a value less than the maximum for g-forces in excess of a selected value.

2. The method of claim 1 wherein the predetermined maximum pressure is within a range of about 5 to 12 inches of water at about a 2.5 g-force and is within a range of about 25 to 35 inches of water at about a 9 g-force.

3. The method of claim 1 wherein the predetermined minimum pressure falls within a range of about 10 to 20 inches of water less than the maximum pressure at any g-force greater than about 4.

4. The method of claim 3 wherein the minimum pressure falls within a range of about 14 to 18 inches of water less than the maximum at any g-force greater than about 4.

5. The method of claim 3 wherein the relationship between the maximum pressure and the g-force is approximately linear for g-forces in excess of about 4 to 5 g-force.

6. The method of claim 1 wherein the maximum pressure gradient α during the inhalation phase is within the range of about 20 to 27 inches H_20.

7. The method of claim 6 wherein the pressure gradient α is about 24 inches H_20.

8. The method of claim 1 wherein the pilot is further equipped with an inflatable chest section and further comprising the step of inflating and deflating the

chest section in synchronism with the gas supplied to and withdrawn from the face mask.

9. The method of claim 8 wherein the pressure in the chest section is approximately the same as the pressure in the mask inlet/outlet port.

10. The method of claim 1 further including inflating the anti-g suit with gas at a pressure which varies nonlinearly over the anticipated g load range.

11. The method of claim 10 wherein the pressure in the anti-g suit increases at a faster rate during acceleration from low g loads to intermediate g loads and at a slower rate during acceleration from intermediate g loads to high g loads.

12. A system for controlling the pressures at which breathable gas is spontaneously inhaled from a high pressure source and exhaled to a low pressure region by a pilot while experiencing excessive g-forces and equipped with an anti-g-force suit comprising:

a face mask having a common inlet/outlet port in fluid communication with the pilot's lungs;

an inhalation valve/pressure regulator subsystem having an inlet connected to the high pressure source and an outlet connected to the inlet/outlet port of the face mask, the inhalation valve/pressure regulator subsystem being arranged to connect the high pressure source to the mask inlet/outlet port in response to a pressure in the mask inlet/outlet port falling below a minimum level and to limit the maximum pressure in the mask inlet/outlet port to a maximum level

in response to the g-force to which the pilot is being subjected; and

an exhalation valve/pressure regulator subsystem having an inlet connected to the inlet/outlet port of the face mask and an outlet connected to a low pressure region, the exhalation valve/pressure regulator subsystem being arranged to connect the mask inlet/outlet port to the low pressure region in response to the pressure in the inlet/outlet port reaching the maximum level and to limit the minimum pressure in the mask inlet/outlet port to the minimum level in response to the g-force to which the pilot is being subjected, with the second level being less than the first level for g-forces greater than a selected value.

13. The invention of claim 12 wherein the inhalation valve/pressure regulator subsystem includes:

a first g-force sensing valve (58) coupled to the high pressure source for establishing the maximum pressure level representative of the g-force;

a normally closed first diaphragm valve (40) connected between the high pressure source and the mask inlet/outlet port; and

a normally closed second diaphragm valve (48) connected to the mask inlet/outlet port and to the first diaphragm valve and responsive to the maximum and minimum pressure levels and the pressure in the mask inlet/outlet port, the second diaphragm valve

being arranged to open the first diaphragm valve in response to the pressure in the mask inlet/outlet port falling below the minimum level by a threshold amount and to close the first diaphragm valve in response to the pressure in the mask inlet/outlet port reaching the maximum level.

14. The invention of claim 13 wherein the exhalation valve/pressure regulator subsystem includes:

a second g-sensing valve (56) coupled to the high pressure source for establishing the minimum pressure level representative of the g-force;

a third diaphragm valve (50) connected between the mask inlet/outlet port and the low pressure region; and

a fourth diaphragm valve (54) responsive to the condition of the inhalation valve for opening the third diaphragm valve in response to the first diaphragm valve closing and for limiting the fluid flow through the third diaphragm valve so that the pressure in the mask inlet/outlet port does not fall below the minimum level.

15. The invention of claim 12 wherein the inhalation valve/pressure regulator subsystem includes:

an accelerometer (88) for generating an output signal representative of the g-force to which the pilot is subjected;

a pressure transducer (84) coupled to the mask inlet/outlet port

for providing an output signal representative of the pressure in the mask inlet/outlet port;

a first proportional valve (74) having an inlet connected to the high pressure source and an outlet connected to the mask inlet/outlet port, the first proportional valve having an input circuit (74a) and being arranged to open or close and control the gas pressure in the outlet thereof when open in accordance with signals applied to its input circuit; and

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a controller (88) responsive to the output signals from the accelerometer and the pressure transducer for determining the maximum and minimum pressure signals and for applying signals to the input circuit of the proportional valve to open the first valve when the change in the signal from the pressure transducer signifies that fluid has commenced to flow into the mask inlet/outlet port and to cause the first valve's outlet pressure to rise at a given rate to the maximum pressure and to close the first valve when the maximum pressure is reached.

16. The invention of claim 15 wherein the exhalation valve/pressure regulator subsystem includes:

a second proportional valve (82) having an inlet (82a) connected to the mask inlet/outlet port and an outlet (82b) connected to the low pressure region, the second proportional valve having an

input circuit (82c) and being arranged to open or close and control the gas pressure in the inlet thereof when open in accordance with signals applied to the input circuit and wherein the microprocessor in response to the accelerometer output signal and the condition of the first proportional valve applies signals to the input circuit of the second proportional valve to open the second valve when the first valve closes and limits the inlet pressure of the second valve to the minimum pressure and to close the second valve upon the opening of the first valve.

17. An apparatus for controlling the pressures at which breathable gas is spontaneously inhaled from a high pressure breathable gas source and exhaled to a low pressure region by a pilot while equipped with an anti-g suit including a pneumatic chest compression section and experiencing excessive g-forces comprising:

a face mask having a common inlet/outlet port in fluid communication with the pilot's lungs and the chest compression section;

a inhalation valve having an inlet connected to the high pressure source and an outlet connected to the mask inlet/outlet port;

at least one g-force sensor;

a pressure sensor/regulator connected to the gas source, the inlet/outlet port of the mask and the inhalation valve and being

responsive to the g-force sensor for opening the inhalation valve to conduct gas from the gas source to the mask inlet/outlet port during the inhalation mode and for closing the inhalation valve when the pressure in the mask inlet/outlet port reaches a maximum value, the maximum value being a function of the g-force to which the pilot is being subjected;

an exhalation valve connected to the high pressure source, the low pressure region and the mask inlet/outlet port; and

a flow sensor/regulator connected to the high pressure source and the inhalation valve outlet and responsive to the g-force sensor for conducting gas from the mask inlet/outlet port to the low pressure region during the exhalation mode while limiting the pressure within the inlet/outlet port to a predetermined minimum value as a function of the g-force, the minimum value being lower than the maximum value for g-forces greater than a selected value.

18. The apparatus of claim 17 wherein said at least one g-force sensor comprises first and second sensors, the inhalation valve is a diaphragm valve (40) and the pressure sensor/regulator is a diaphragm valve (48) having pressure actuating chambers disposed on upper and lower sides of the diaphragm with the upper chamber (48c) being in fluid communication with the mask inlet/outlet port and the lower chamber (48b) being in fluid communication with the gas source, the inhalation valve and the first g-force sensor, the pressure sensor diaphragm valve

further including a bias member for closing the pressure sensor diaphragm valve when the pressure in the upper chamber is equal to or greater than the pressure in the lower chamber and for opening the valve when the pressure in the lower chamber is greater than the pressure in the upper chamber.

19. The apparatus of claim 18 wherein the exhalation valve is a diaphragm valve (50) and the flow sensor/regulator is a diaphragm valve (54) having pressure actuating chambers disposed on upper and lower sides of the diaphragm with the upper chamber 54c in fluid communication with the inhalation valve outlet and the lower chamber (54b) in fluid communication with the gas source, the exhalation valve and the second g-force sensor.

20. The apparatus of claim 17 wherein the inhalation valve is an electrically responsive proportional valve (74), the g-force sensor is an accelerometer (88) and the pressure sensor/regulator comprises a pressure transducer (84) and a microprocessor (88).

21. The apparatus of claim 20 wherein the exhalation valve is an electrically responsive proportional valve (82) and the flow sensor/regulator comprises the pressure transducer (84) and the microprocessor (88).

22. In an apparatus for controlling the maximum and minimum pressure at which breathable gas in inhaled and exhaled, respectively, from a high pressure source by a pilot equipped with an anti-g suit and experiencing g-force above a preselected value, the maximum and minimum pressures varying in accordance with the g-force, the combination comprising:

a face mask having a common inlet/outlet port in fluid communication with the pilot's lungs;

an inhalation valve connected between the high pressure source and the mask inlet/outlet port;

an exhalation valve connected between a low pressure region and the mask inlet/outlet port;

a pressure sensor responsive to the minimum pressure and the pressure in the mask inlet/outlet port for opening the inhalation valve and closing the exhalation valve when the pressure in the inlet/outlet port falls below the minimum pressure by a threshold of sensitivity level;

an exhalation pressure sensor responsive to the maximum pressure and the pressure in the mask inlet/outlet port for closing the inhalation valve and opening the exhalation valve when the pressure in the mask inlet/outlet port reaches the maximum value, whereby the pressure in the mask inlet/outlet port will decrease to the minimum value.

23. An improvement in the method of providing physiological protection for a pilot experiencing excessive g-force while wearing an anti-g suit, a chest bladder and a face mask with a common inlet/outlet port, the anti-g suit and chest bladder being pressurized in accordance with the g-forces, the improvement comprising:

supplying breathable air to the mask inlet/outlet port during

the pilot's spontaneous inhalation phase commencing at a first pressure level and ending at a second higher pressure level; and

connecting the mask inlet/outlet port to a low pressure region during the pilot's exhalation phase while allowing the pressure in the mask inlet/outlet port to fall from the second level to the first level whereby the stress resulting from the exhalation phase is minimized.

24. An g-responsive pressure regulator assembly having an inlet adapted to be connected to high pressure gas source and an outlet adapted to be connected to a pilot's anti-g suit for supplying gas under a regulated pressure thereto comprising:

at least one g load sensing element; and

a flow control valve connected between the inlet and outlet and being responsive to the g load as sensed by the at least one g sensing element for controlling the flow of gas into and out of the anti-g suit so that the outlet pressure is nonlinear with respect to the g load over the anticipated g load range.

25. The g-responsive pressure regulator assembly of claim 24 wherein the flow control valve is arranged to control the flow of gas into and out of the anti-g suit so that the rate of pressure increase in the anti-g suit is higher during acceleration from low g loads to intermediate g loads and lower during acceleration from intermediate g loads to high g loads.

26. The g-responsive pressure regulator of claim 27 wherein the at least one g sensing element comprises a plurality of g sensing elements.

27. The g responsive pressure regulator of claim 26 wherein the flow control valve comprises a diaphragm valve and wherein the pressure regulator assembly includes a source of reference pressure (102b) and means including the g-sensing elements for opening and closing the flow control valve to maintain the outlet pressure approximately equal to the reference pressure.

28. The g-responsive valve of claim 27 including a low pressure region and wherein the source of reference pressure includes a reference chamber connected to the pressurized source via a restrictor and wherein each of the g-sensing elements are arranged to allow gas to flow from the reference chamber to the low pressure region when the pressure in the reference chamber exceeds a predetermined value as set by the sensed g load by the respective g-sensing element .

29. The g-responsive valve of claim 28 wherein each of the g-sensing elements comprises a spring biased weight positioned over a respective opening between the reference chamber and low pressure region.